NASA SBIR/STTR Technologies

A1.03-8199 - Spatially and Temporally Resolved Diagnostics of Dense Sprays Using Gated, Femtosecond, Digital Holography

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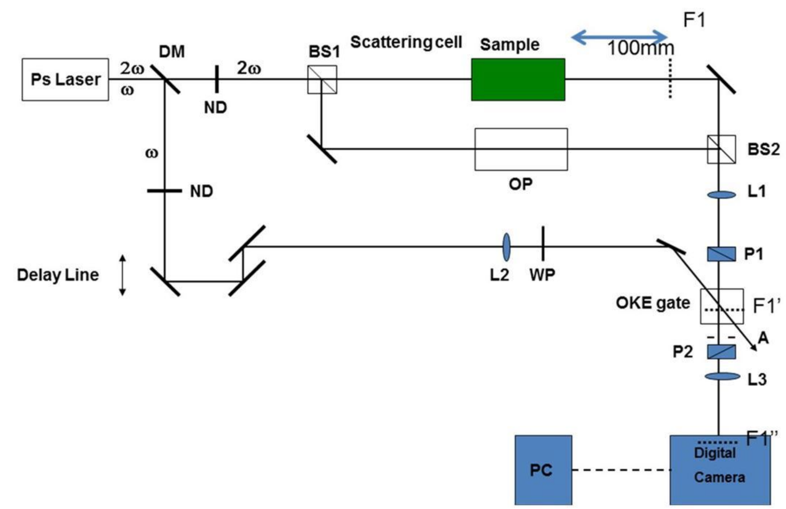
Identification and Significance of Innovation

Viewing atomization processes is vital in combustion science. Existing methods do not resolve three dimensions. Digital holography combines holography and electro optics to produce a powerful combustion diagnostics tool. Integrating holography and ballistic imaging technique reduces optical noise, improves ballistic photon imaging, adds a third dimension, provides image gain and coherence filtering, and improves overall image quality. We propose a unique, gated, picosecond, digital holography system, providing a new tool capable of characterizing dense fuel particle and droplet fields under harsh, high pressure conditions, including combustion. Since the complete wavefront is captured in a hologram, comparison with other reference wavefronts, provide sensitive interferometry diagnostic at the same time, enabling a detailed look at the pressure and temperature field surrounding particles.

Estimated TRL at beginning and end of contract: (Begin: 3 End: 5)



Technical Objectives and Work Plan

The objective is to develop gated picosecond digital ballistic holography for high pressure combustion environments, and produce high quality imagery in dense sprays including holographic interferometry. Combining methods of digital, picosecond, particle holography with pseudo ballistic imaging produces a system that 1) measures diameter of aerosol particles, distinguishes shapes, and locates particles in 3D, 2) provides multiple framing capability for recording the dynamics of high frequency phenomena, 3) measures the aerosol and coarse spray features (approx. 0.1-10 mm), 4) eliminates optical noise arising from multiple, wide angle, scattering and 5) provides interferometry. Breadboard experiments will demonstrate the feasibility of achieving these measurements in high pressure dense sprays and will determine how short a gating pulse can be and still allow good quality holograms. Our approach uses existing MetroLaser and UC Irvine equipment to achieve Phase I goals. We will design and produce a breadboard digital holography system to simulate the system and the conditions anticipated in the final system application, and will apply the breadboard instrument to demonstrate its capability. These experiments will take place in the combustion laboratories of UCI which currently has all of the required hardware for achieving Phase I goals.

NASA Applications

The tool developed in this research can provide data in combustion research that is not currently attainable with other methods and therefore can have an impact on future aircraft engine combustor designs. The system is applicable in studies requiring fuel air ratios, particle size and number density and refractive index gradients in the gases surrounding the particles.

Non-NASA Applications

The resulting tool can enhance combustion research in commercial engine development leading to lower emission, control instabilities and may have commercial applications in other gas-turbine based industries (such as power generation and industrial burners).

Firm Contacts

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